Met Office
Hadley Centre

Walker INSTITUTE

Tyndall Centre
for Climate Change Research

Grantham Institute
for Climate Change

AVOID is a UK research programme funded by DECC/Defra and led by the Met Office in a consortium with the Walker Institute, Tyndall Centre and Grantham Institute.

DEPARTMENT OF ENERGY & CLIMATE CHANGE

defra
Department for Environment Food and Rural Affairs

Living With Environmental Change

Can we limit warming to 2 °C?

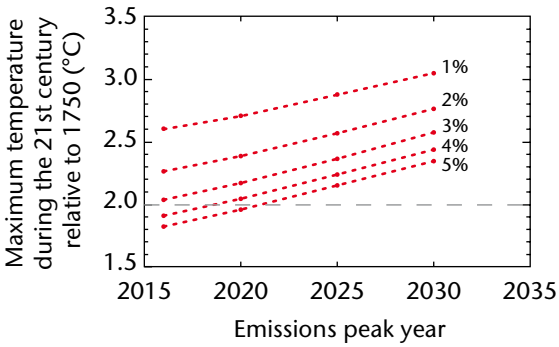
There is now international agreement from the G8/G20 and in the Copenhagen Accord[1] that to avoid dangerous climate change, warming should be limited to 2 °C or less above pre-industrial levels. Greater warming could lead to potentially intolerable climate impacts and is more likely to trigger accelerated or irreversible environmental changes.

The AVOID[2] programme — led by the Met Office in a UK consortium with the Walker Institute, Tyndall Centre and Grantham Institute — has demonstrated that it is possible to restrict warming to 2 °C or less during the 21st century with at least a 50% probability.

KEY FINDINGS

- AVOID has shown that limiting global warming to 2 °C is possible but challenging. **Early global action** increases the chances of remaining below this level.
- For a 90% chance of staying below 2 °C, AVOID results show that we will probably need **negative emissions and/or some geo-engineering** intervention.
- There is some limited **flexibility in the year of peak emissions** and the emissions in 2020. The later the peak year, the stronger the action must be to reduce emissions after the peak. This may be beyond economic and technological feasibility.

  For example: Should emissions peak in 2016, to limit warming to 2 °C with a 50% probability will require emissions reductions of approximately 4% per year. But should emissions peak later in 2020, to achieve the same temperature target will require a faster rate of emissions reductions of almost 6% per year.
- **Emissions after 2050 matter**. For instance, an extra 100 years of carbon dioxide (CO_2) emissions at just a fifth of the year 2000-level could add more than 0.3 °C to peak warming.



Which emission trajectory yields a temperature that remains below 2 °C, 3 °C or 4 °C with at least a 50% probability? The 2 °C target is taken here to mean 2 °C at 2100 relative to pre-industrial (1750).

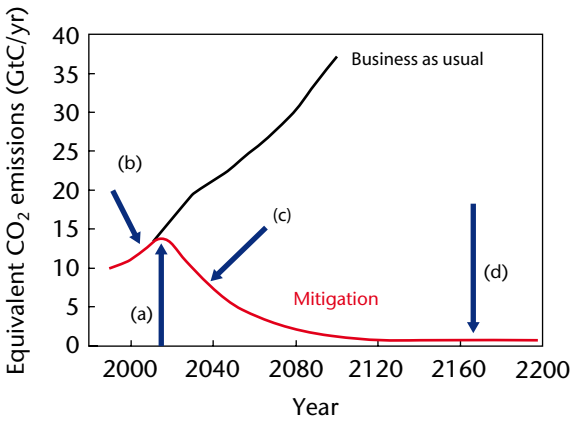
- **How the 2 °C target is defined** is a very important consideration. It has implications for the level of action required and the impacts that are avoided by taking action instead of continuing with business as usual.

1 The Accord does not specify a baseline period for temperature, but scientific analysis typically assumes this to be pre-industrial.
2 Avoiding Dangerous Climate Change.

WHAT IS THE 2 °C TARGET?

The following issues need to be considered:

- **Timescale** — the target can be defined so that i) it is met only during 21st century, but not later; ii) it is met during 21st and 22nd centuries but not later; and iii) it is met forever (taken as 2500 in our simulations).
- **Acceptable level of risk** — the UK Committee on Climate Change worked with the aim of staying below 2 °C up to 2100 with at least approximately a 50% probability. The choice of an acceptable level of risk is a political one, but the science can provide information on the consequences of alternative choices.

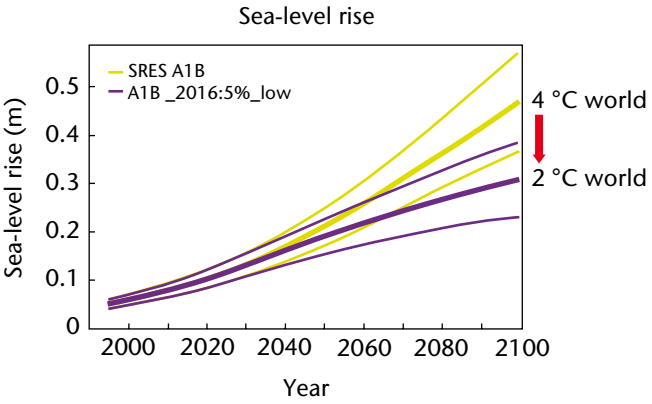


Mitigation scenario: Key parameters to vary — a) year of peak emissions; b) rate of pre-peak emission increase; c) post-peak rate of emission reduction; d) long-term emissions floor.

WHAT DOES THIS MEAN FOR SEA-LEVEL RISE?

Stabilising greenhouse gas concentrations in the atmosphere can significantly reduce the rate of warming, levelling it out significantly in a few decades. Moving from a world heading towards, say, a 4 °C rise in global average temperature to one where warming is limited to a 2 °C rise is an enormous task, but one that might also avoid up to a third of predicted 21st century sea-level rise. Going from a 4 °C world to a 2 °C world would also lower the chance of triggering irreversible melting of the Greenland ice-sheet, which could eventually add several metres to sea-levels across the globe.

However, even a very large reduction in emissions will not avoid all future increases in temperature or sea-level. In the case of sea-level, the increases are likely to continue for several hundred years after greenhouse gas concentrations are stabilised.



The green lines show the response in an unmitigated world that reaches 4 °C by 2100, compared to a world with rapid and early mitigation that limits warming to 2 °C by 2100 (purple lines). The thick lines correspond to the medium model response and the thin lines show the uncertainty range.

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